

VENUS

The Virtual Environment for Neutrinos

Marco Del Tutto

24th July 2022

Snowmass 2022 - Seattle



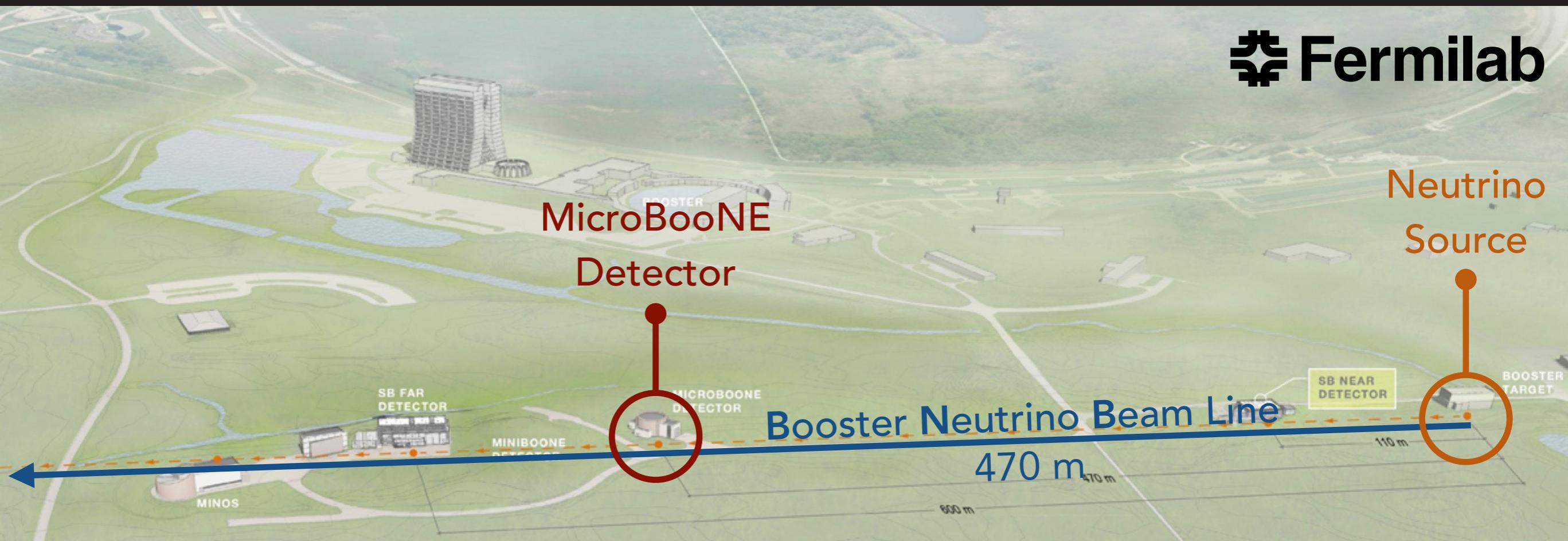
What is it?

VENu is an event display for the MicroBooNE experiment
It was developed mainly between 2015 and 2018 (I will talk about this)
Today, it is being upgraded and ported to other experiments



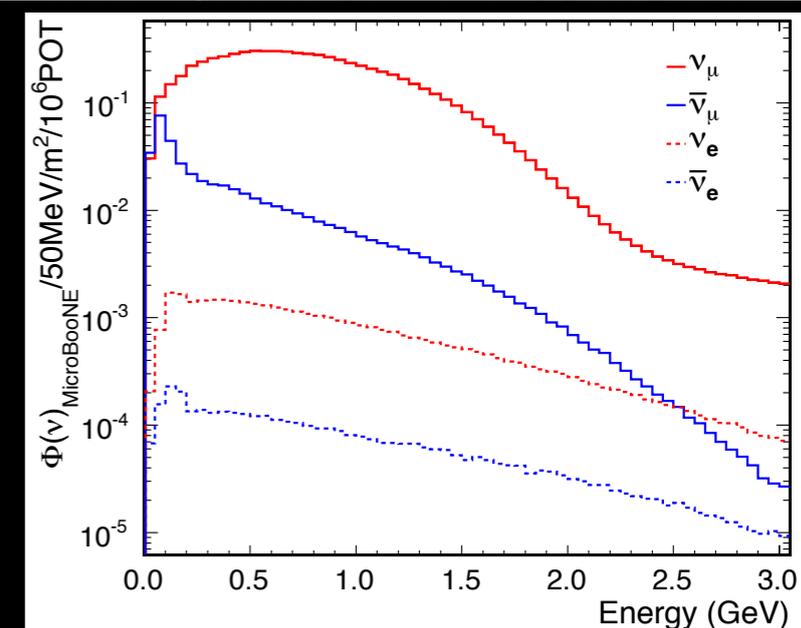
- ▶ MicroBooNE is a neutrino experiment at Fermilab
- ▶ The neutrino detector is a Liquid Argon Time Projection Chamber
- ▶ VENu allows users to virtually go inside the detector

MicroBooNE

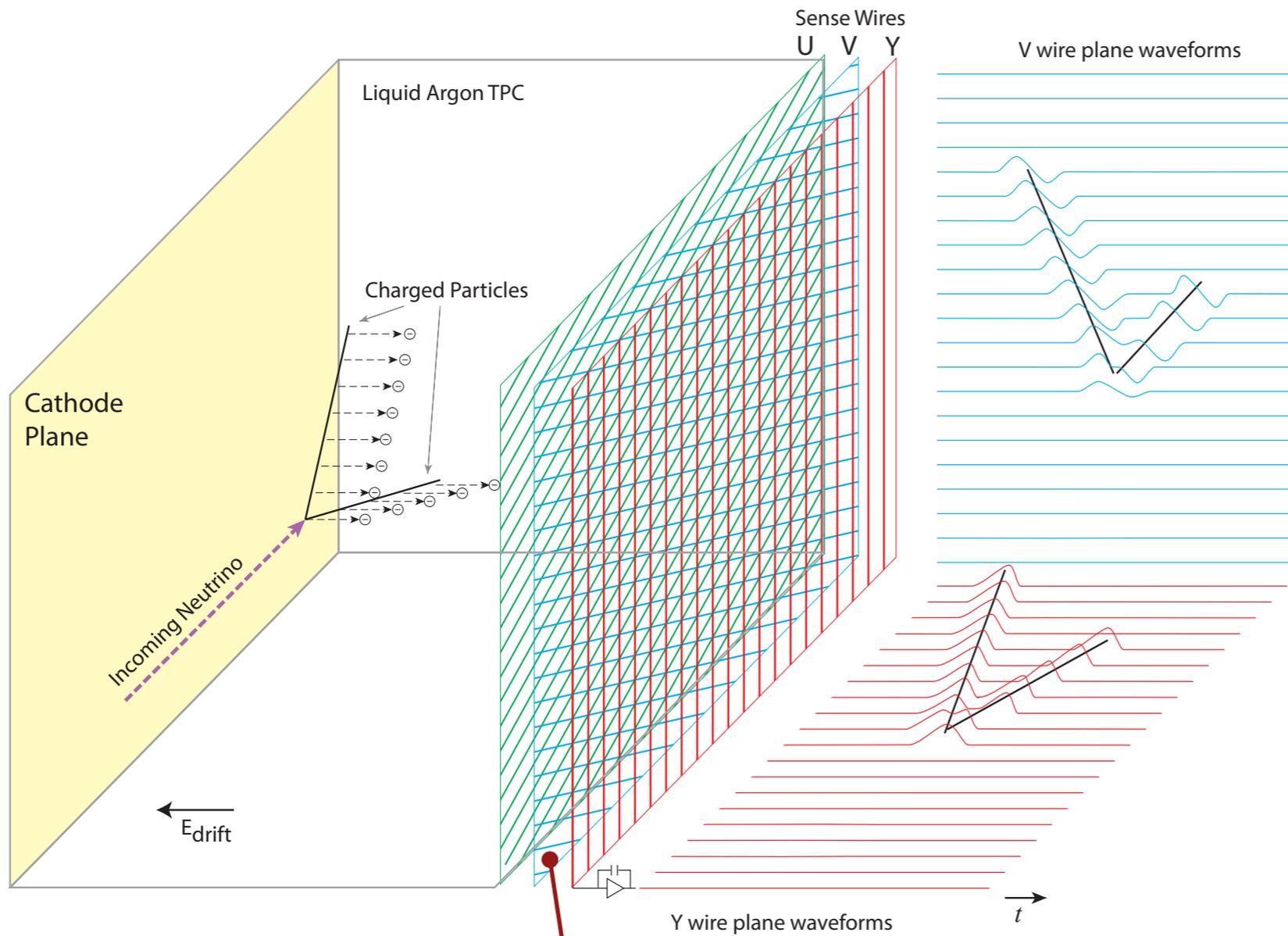


Goals of **MicroBooNE**:

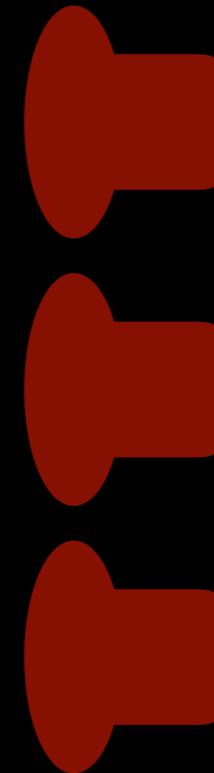
- ▶ low-energy excess observed by MiniBooNE
- ▶ SBN search for sterile neutrinos with 5σ sensitivity
- ▶ ν -Ar cross section measurements
- ▶ R&D for future LArTPC experiments



MicroBooNE



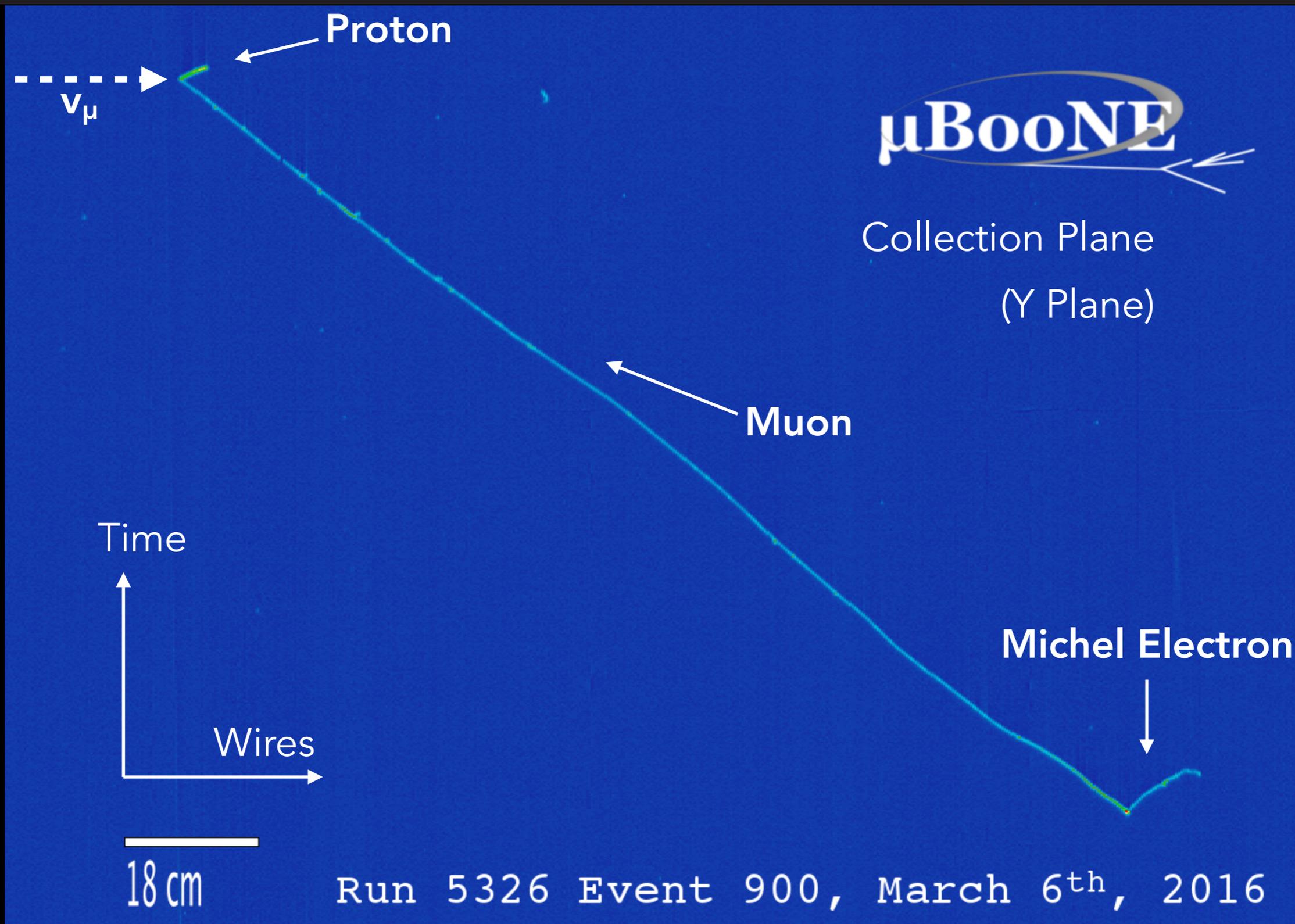
170 ton LArTPC (total mass)



32 8"
Cryogenic
PMTs

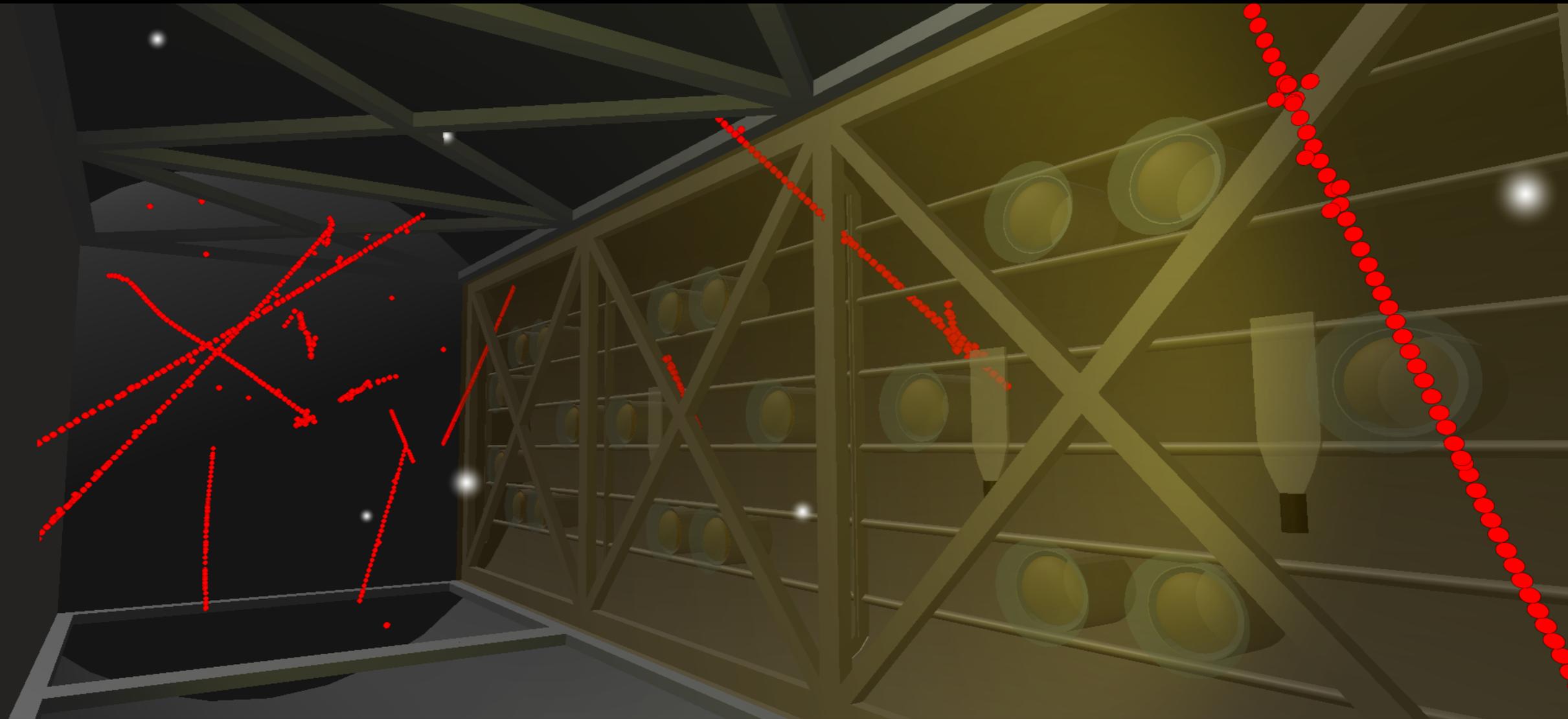
8192 wires (3 mm pitch)

MicroBooNE



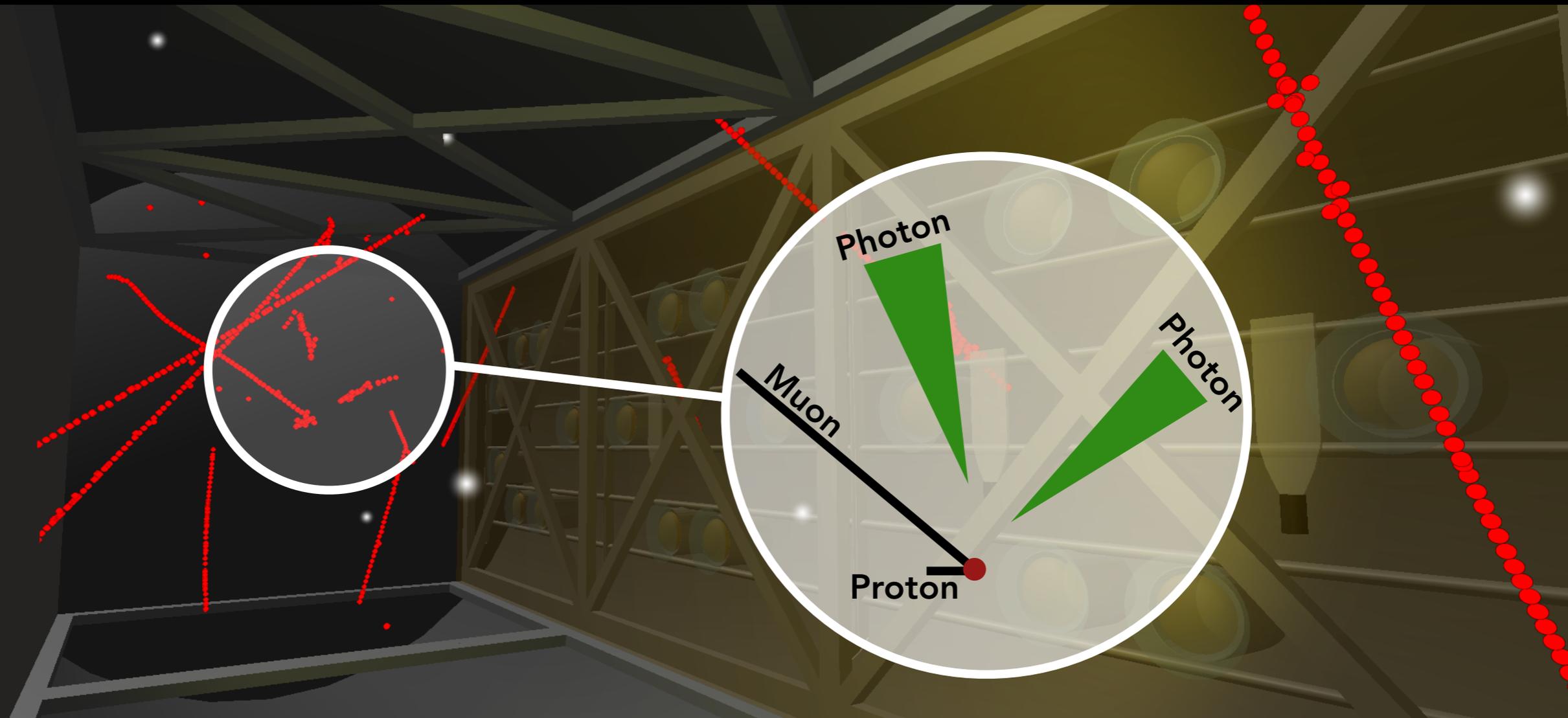
What is it?

VENu... ..is built and rendered in a 3D environment



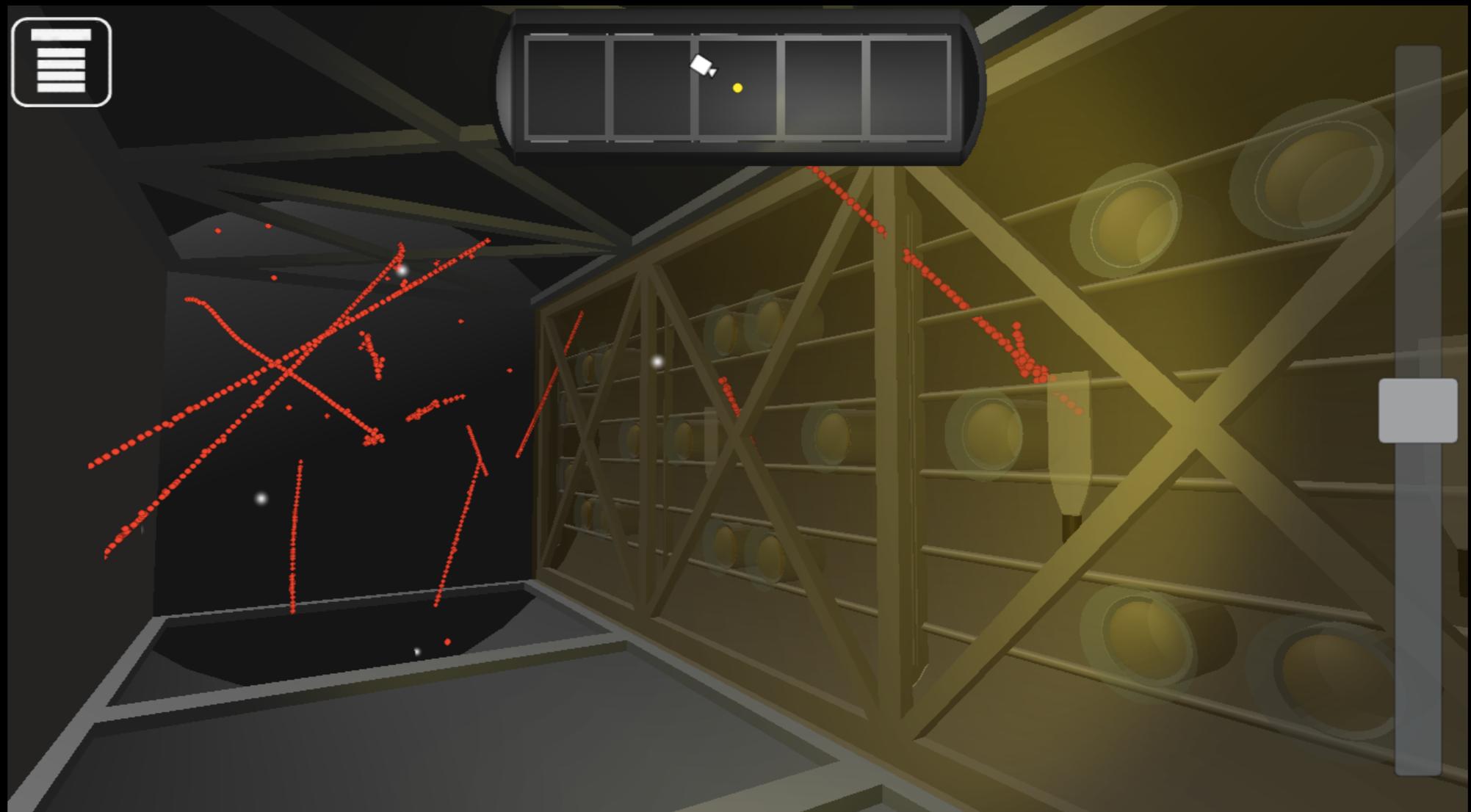
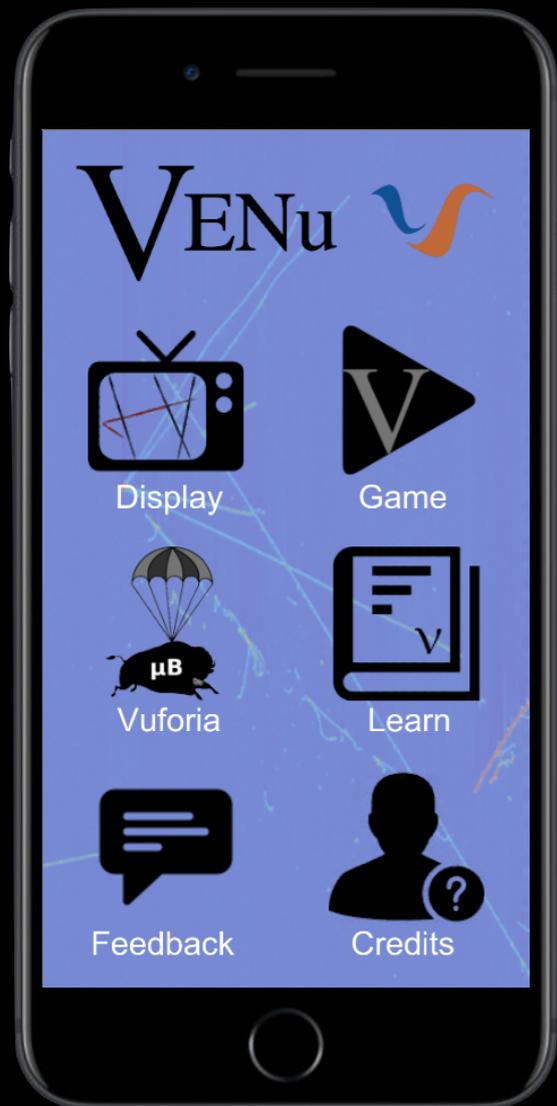
What is it?

VENu... ..displays actual neutrino interactions from the **MicroBooNE** detector



What is it?

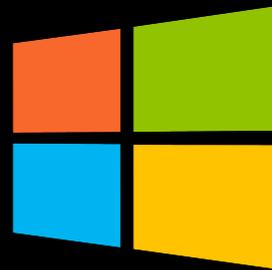
VENu runs on smartphones



What is it?



VENu... ..is a multi-platform **event display**



Desktops



Smartphones



Web

What is it?

VENu... ..is a mobile app



iOS

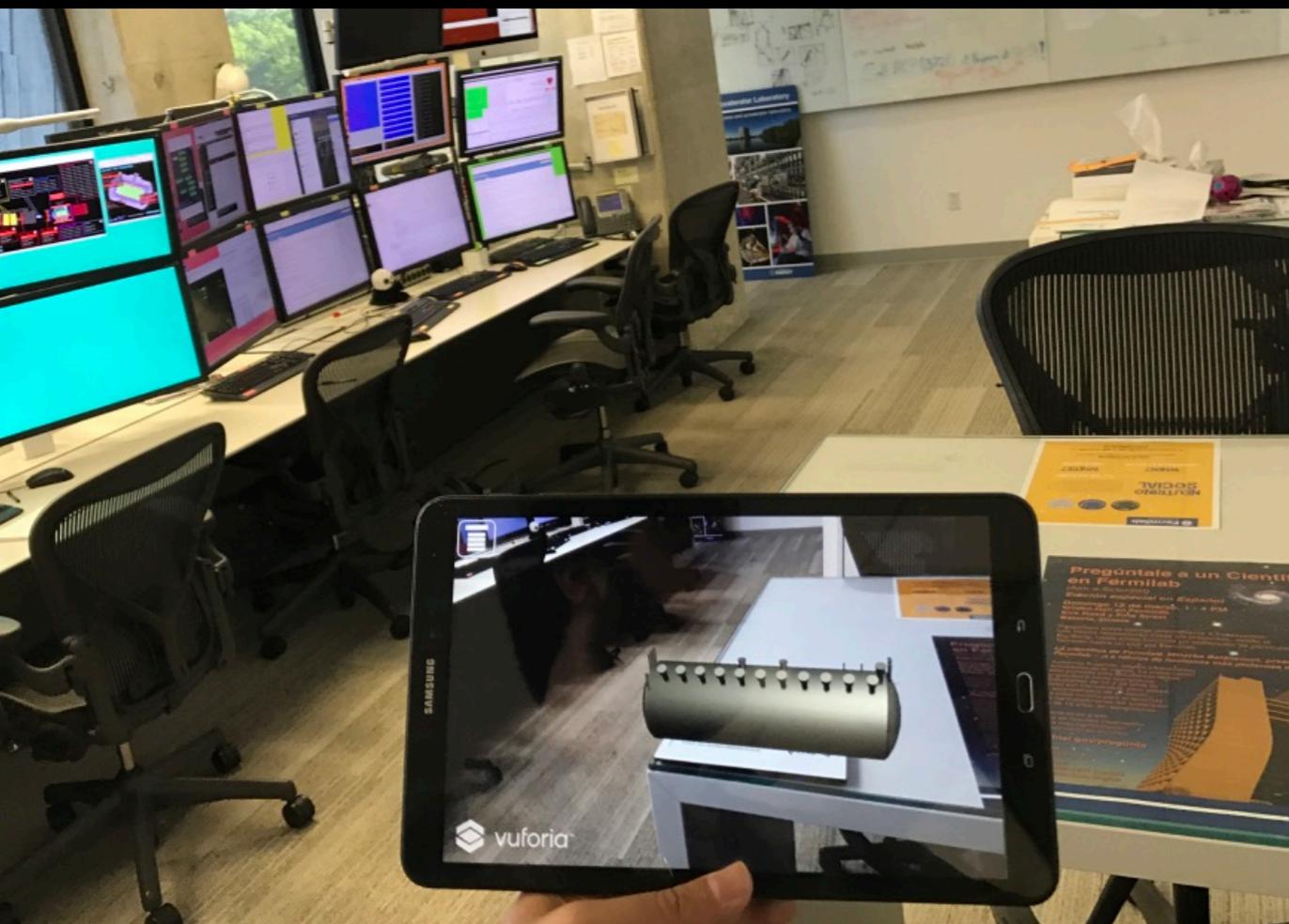


Android

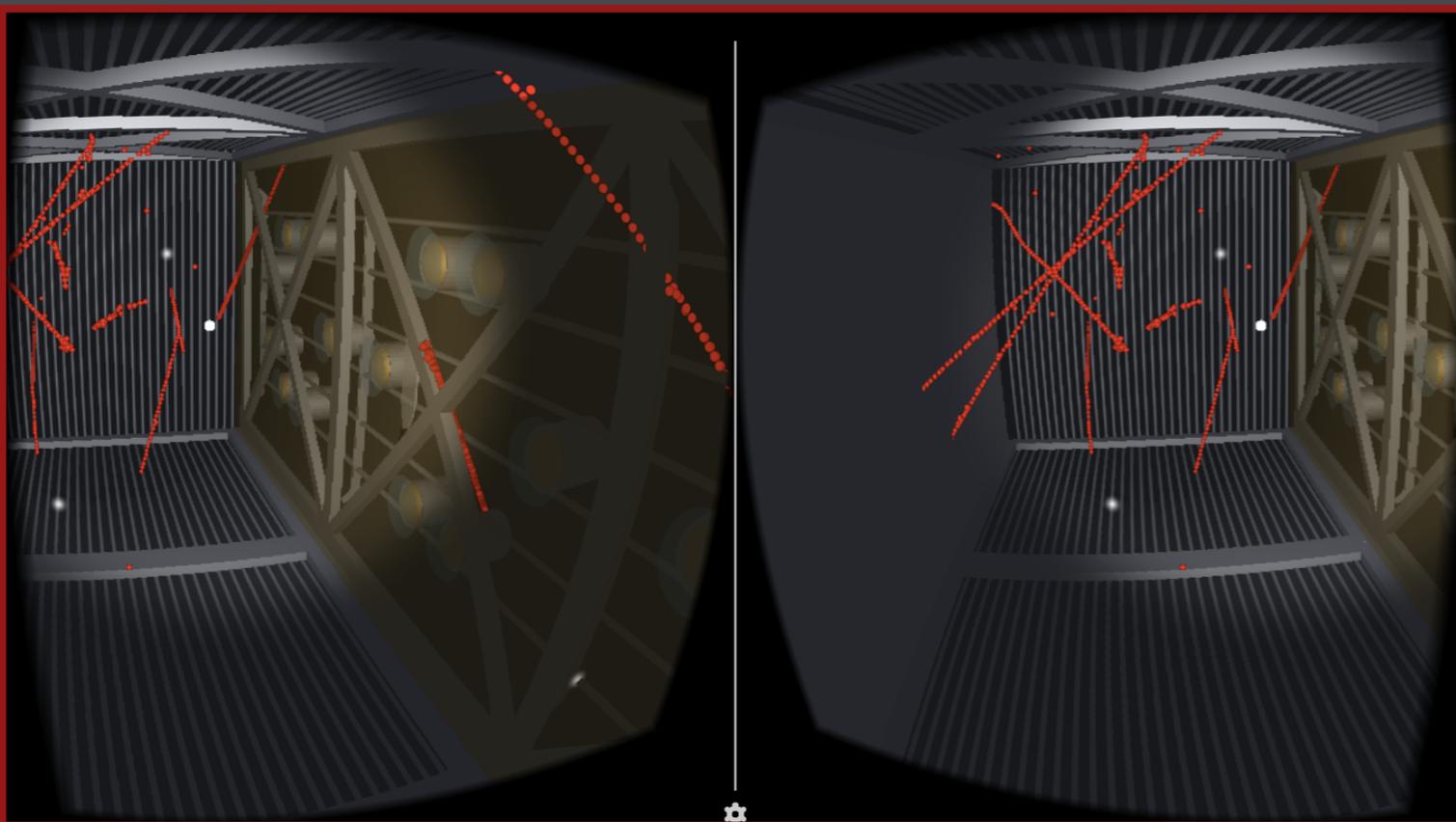
What is it?



VENu... ..is designed to exhibit both augmented and virtual reality features



Google Cardboard



Google Cardboard

Uses smartphone for display, rotating tracking and processing



Oculus Rift

Tracks lateral motion of the head
Tracks the position of motion controller



Google Cardboard

Uses smartphone for display, rotating tracking and processing



Oculus Rift

Tracks lateral motion of the head
Tracks the position of motion controller



- We have an Oculus Rift version of VENu
- Needs a powerful computer to run
- Currently used in outreach events
- But not portable

Google Cardboard

Uses smartphone for display, rotating tracking and processing



Oculus Rift

Tracks lateral motion of the head
Tracks the position of motion controller



- Can be paired with many of the smartphones available on the market
- Portable
- Not expensive (can be used as gadget)
- Limited by smartphone performances

Why?

50%

Characterize
scientists as
secretive

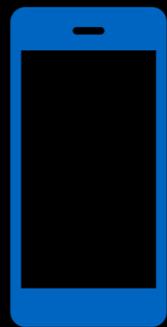
55%

Believe science is
too specialized for
them to understand

Why?

50%

Characterize
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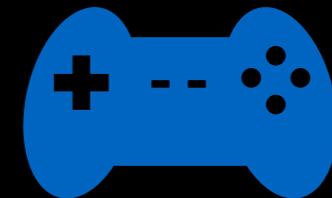
Mobile App

55%

Believe science is
too specialized for
them to understand



Learning sections

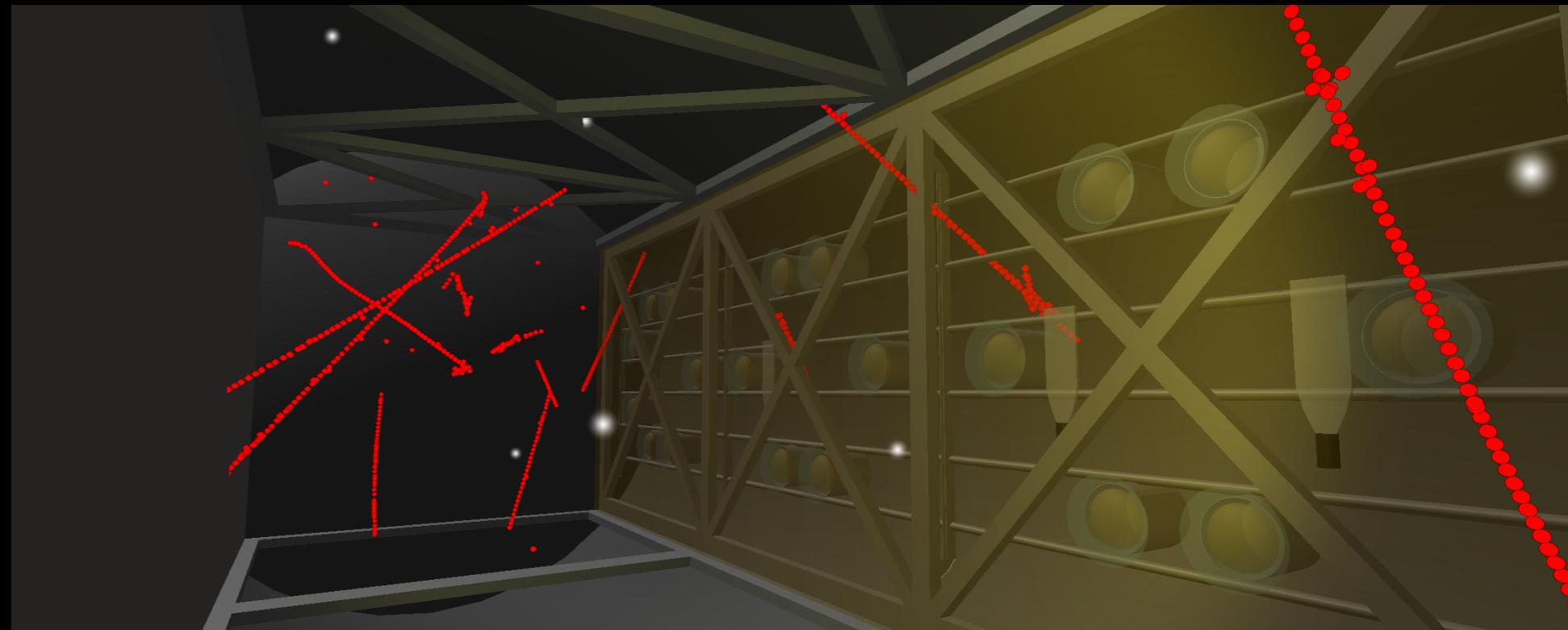


Game

Why?

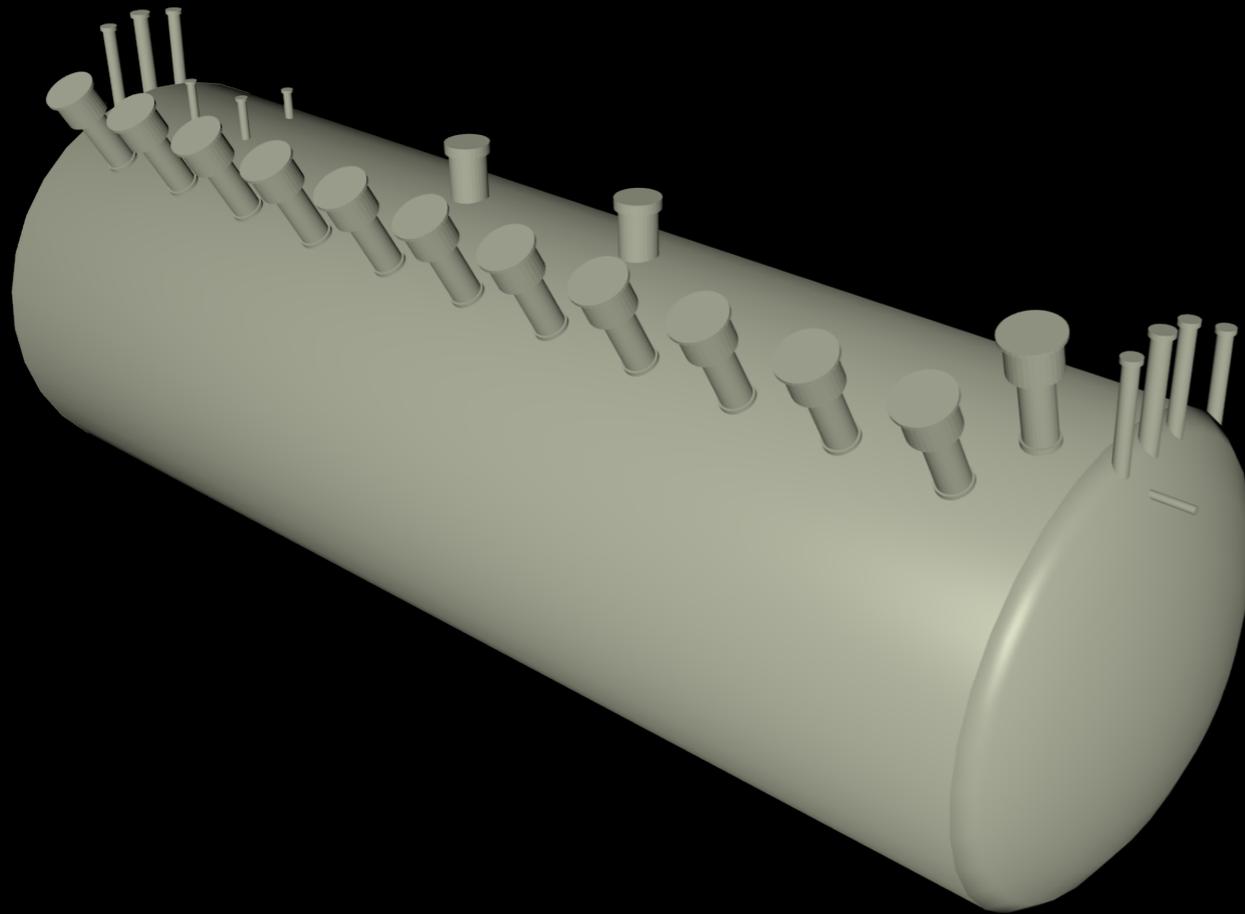
- Connections with the **general public**;
- The **educational game** included in the application will allow young people to hunt neutrinos and to learn more about them in a **fun environment**;
- To offer a tool for neutrino physicists to **interact with the public** while describing their research.

How did we do it?



We used Blender to render the detector geometry

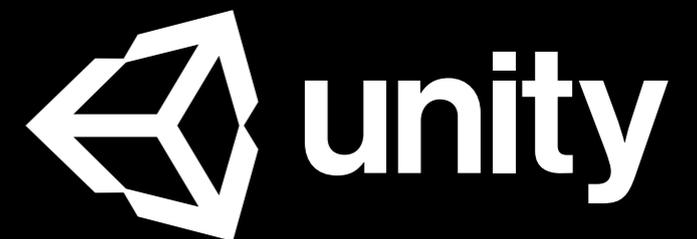
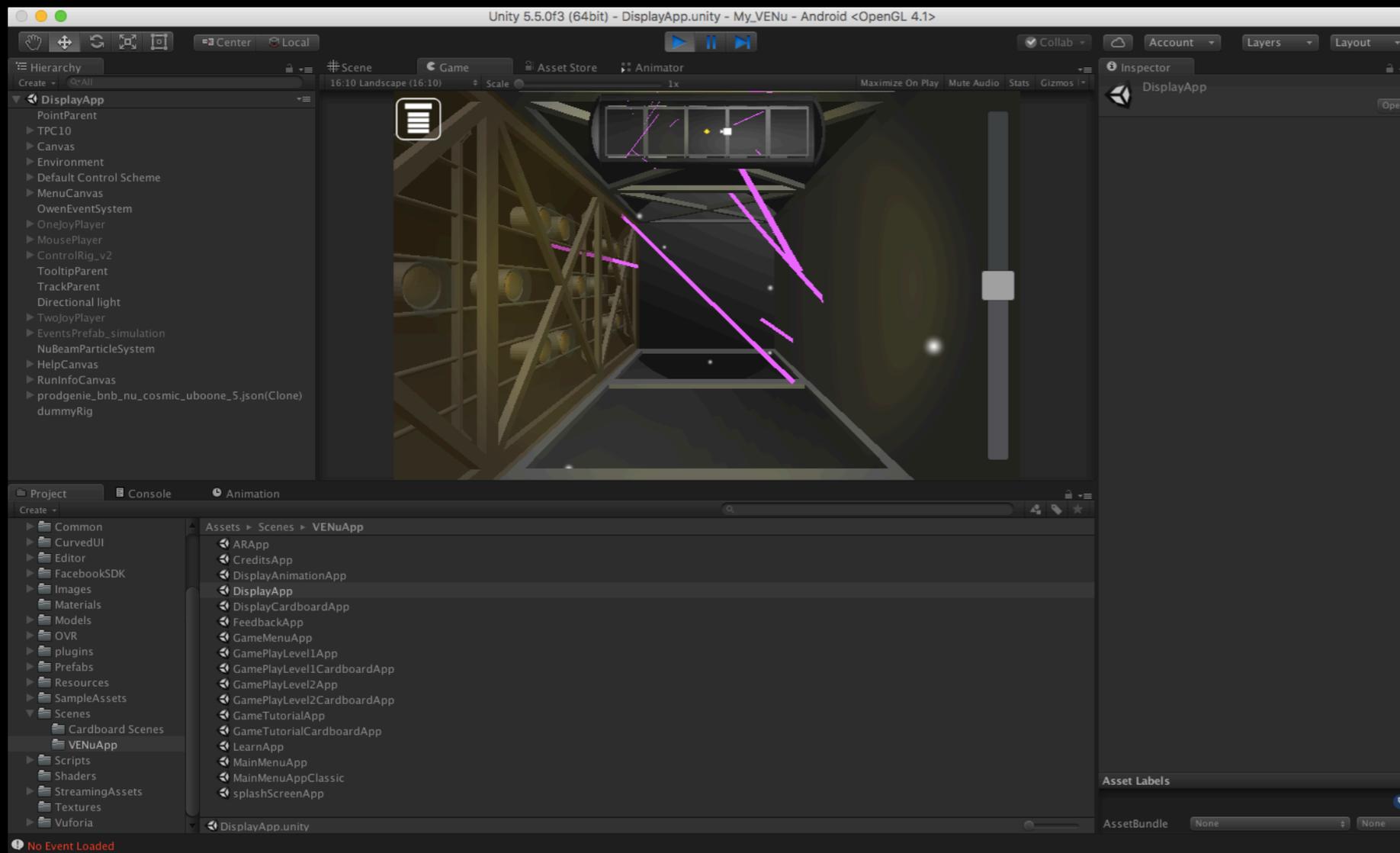
Blender is an open-source 3D modeling software, that imports easily into Unity



Development



We built VENu using the Unity game engine



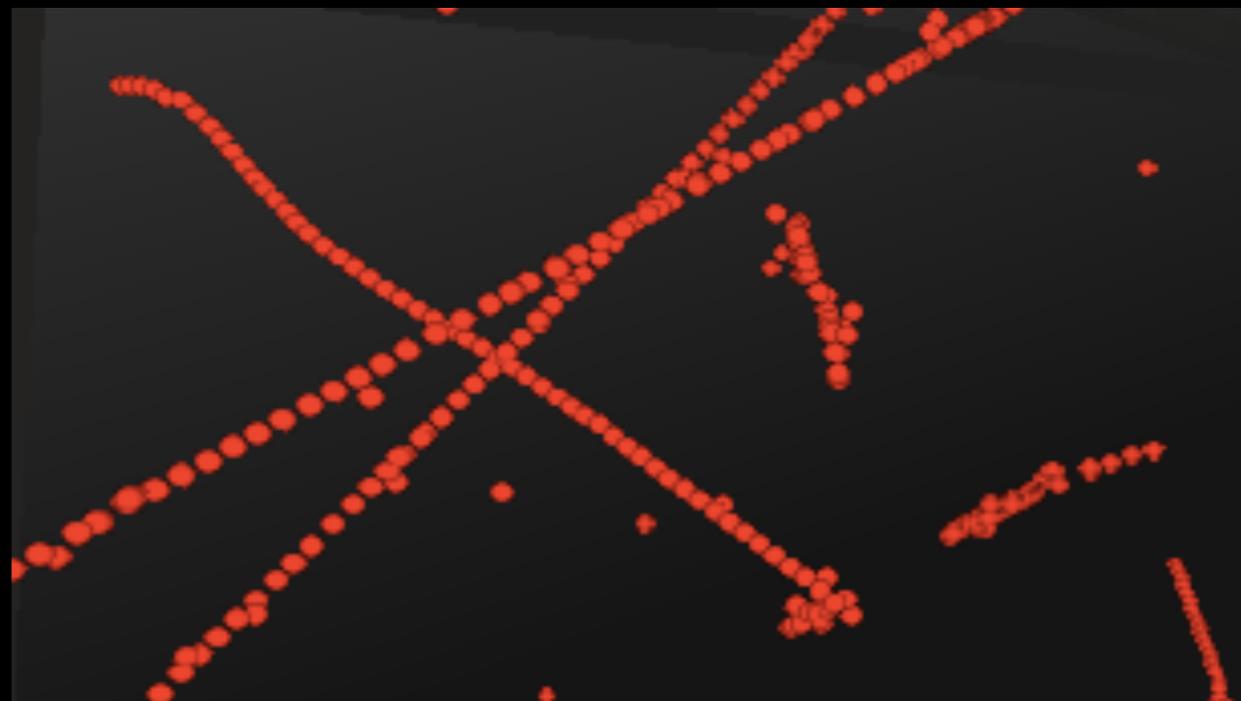
v5.5

Development

The data from the MicroBooNE detector are processed in a simplified json format.

They are then transformed into Unity prefabs.

prefabs in Unity are assets that allow to store a game object (like a particle trajectory)



Development



The data from the MicroBooNE detector are processed in a simplified json format.

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prefabs in Unity are assets that allow to store a game object (like a particle trajectory)

All code available on GitHub!

<https://github.com/VENuProject>

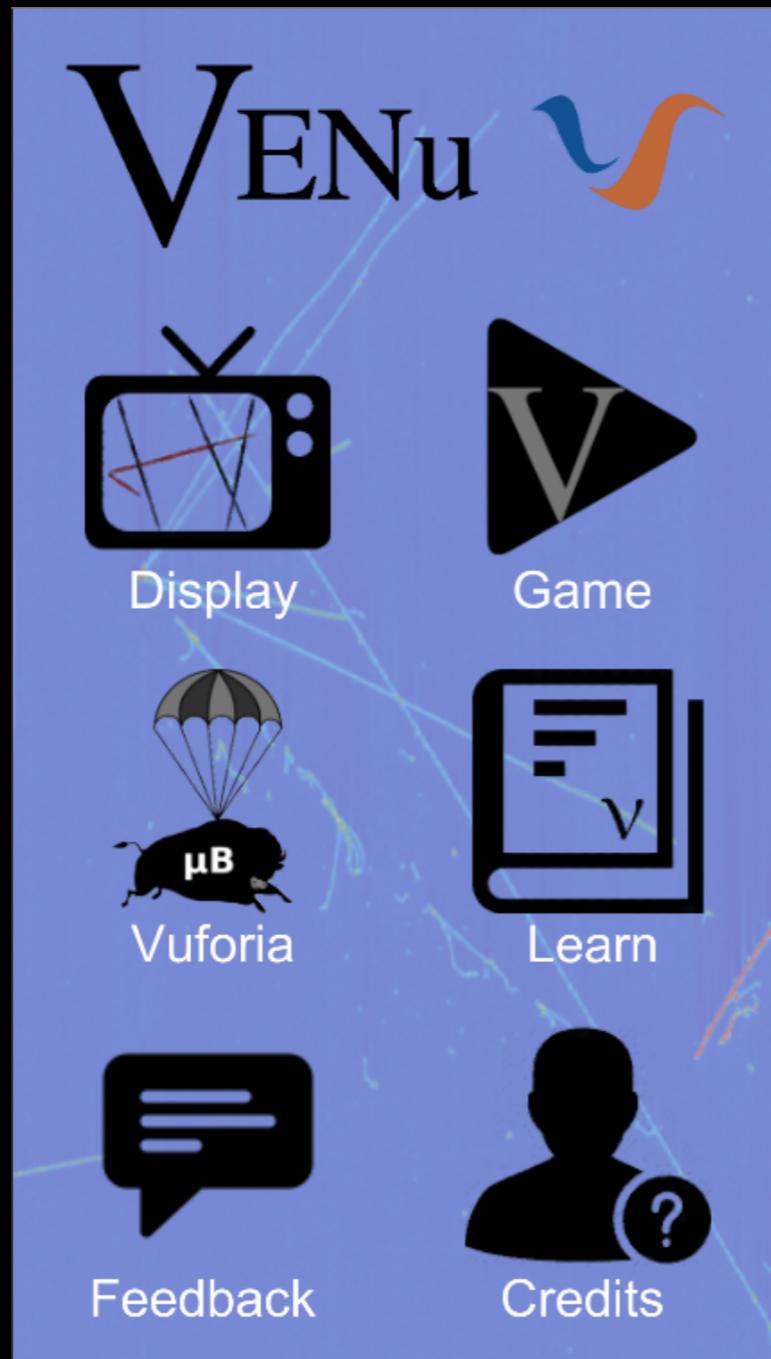


History

- **December 2015** first idea to develop VENu for smartphones
-  Development...
- **October 2016** testing among MicroBooNE collaborators
- **November 2016** testing with students at Arnold Matthew School (Oxford)
- **December 2016** website construction
- **January 2017** launch! 
- **Up to now** outreach events

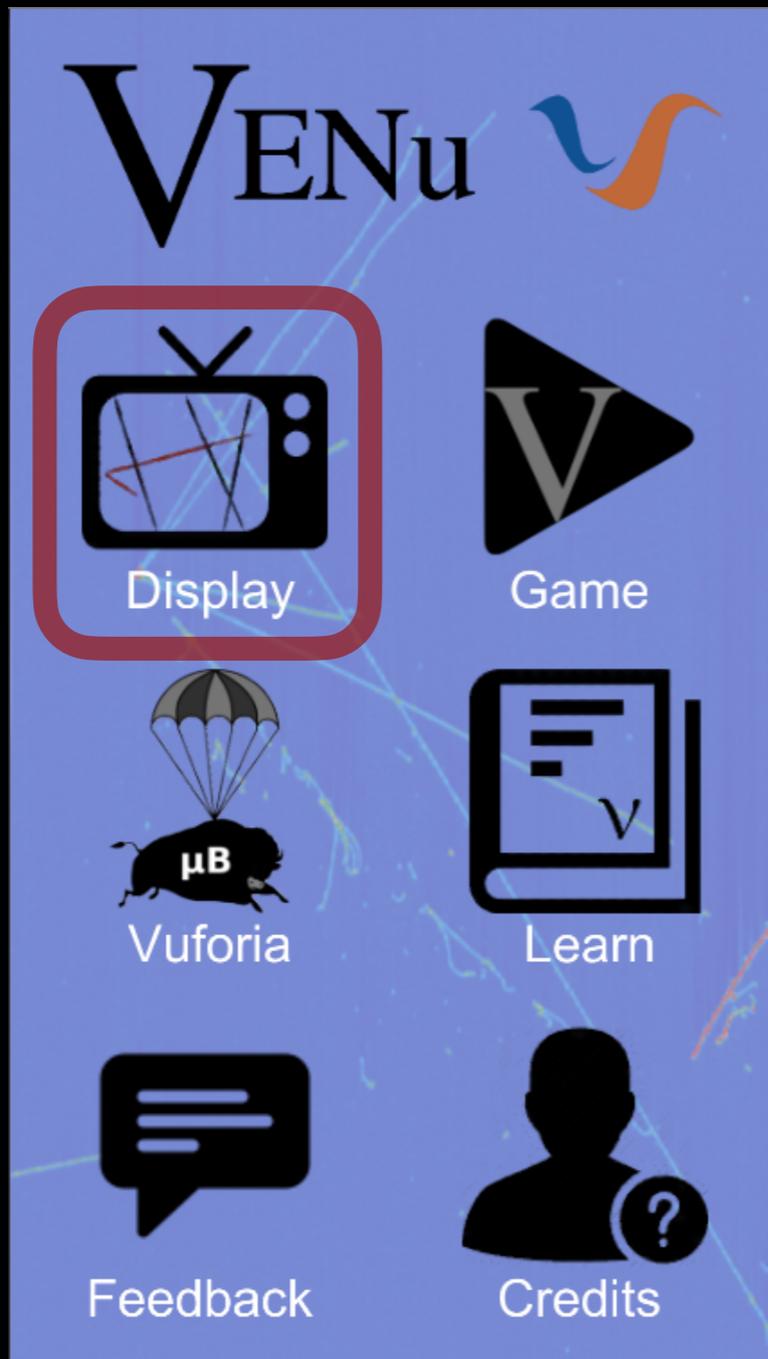
The Menu

Main Menu

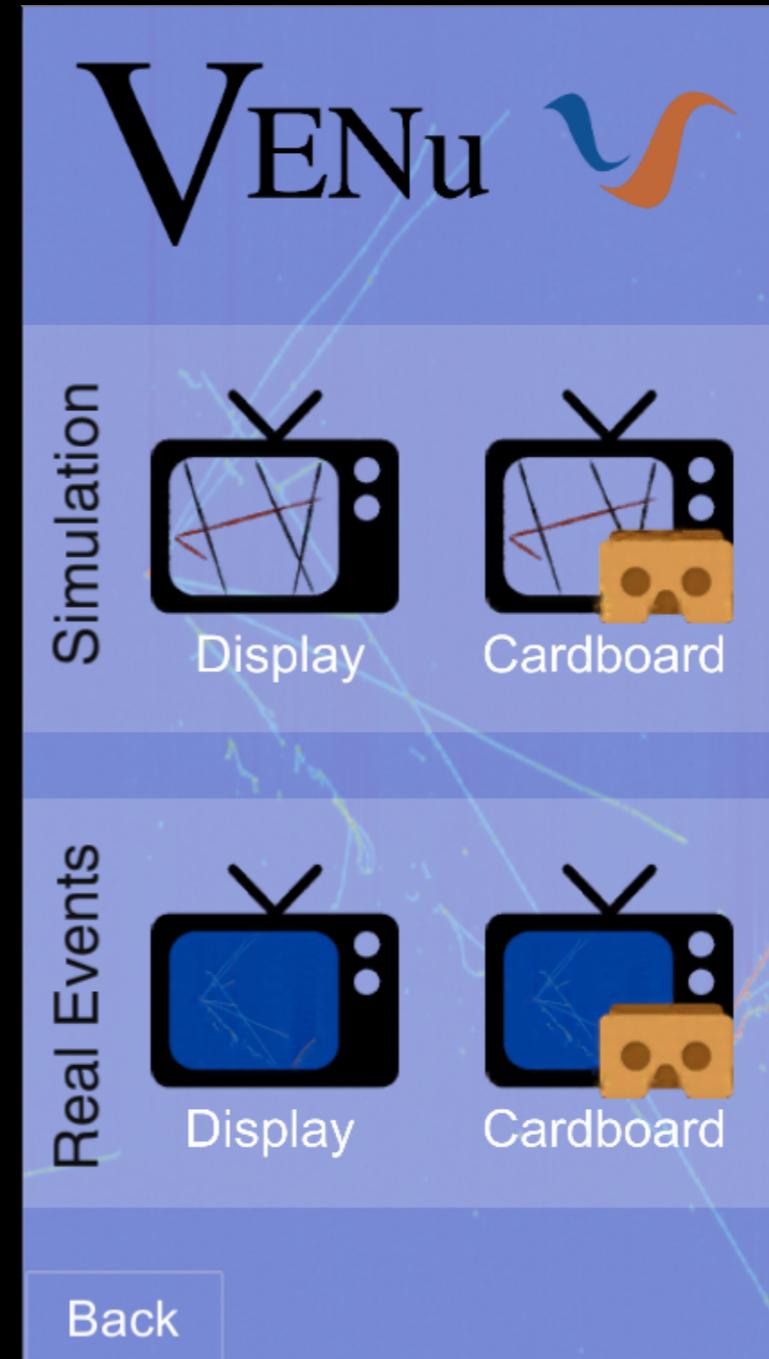


The Menu

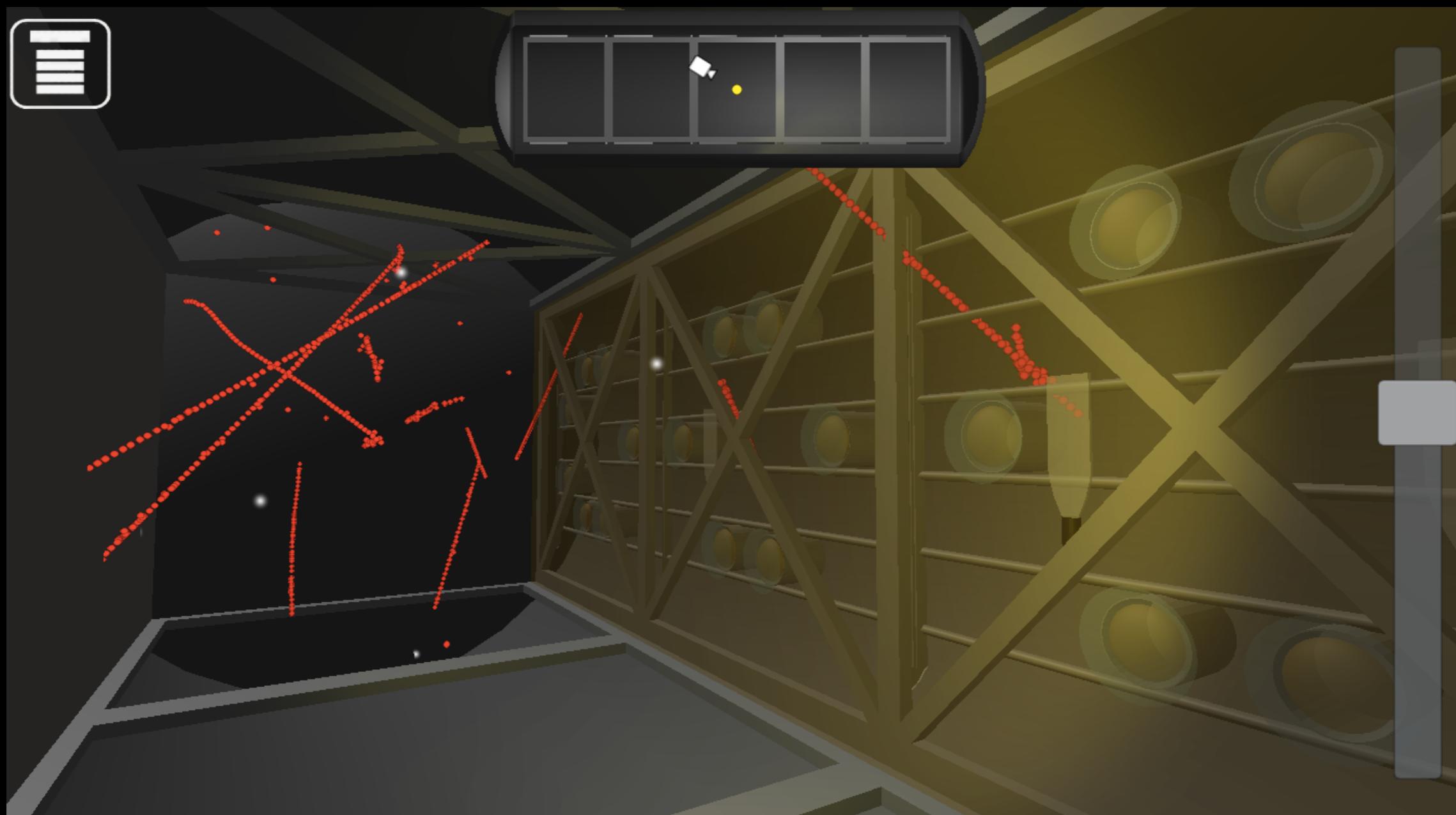
Main Menu



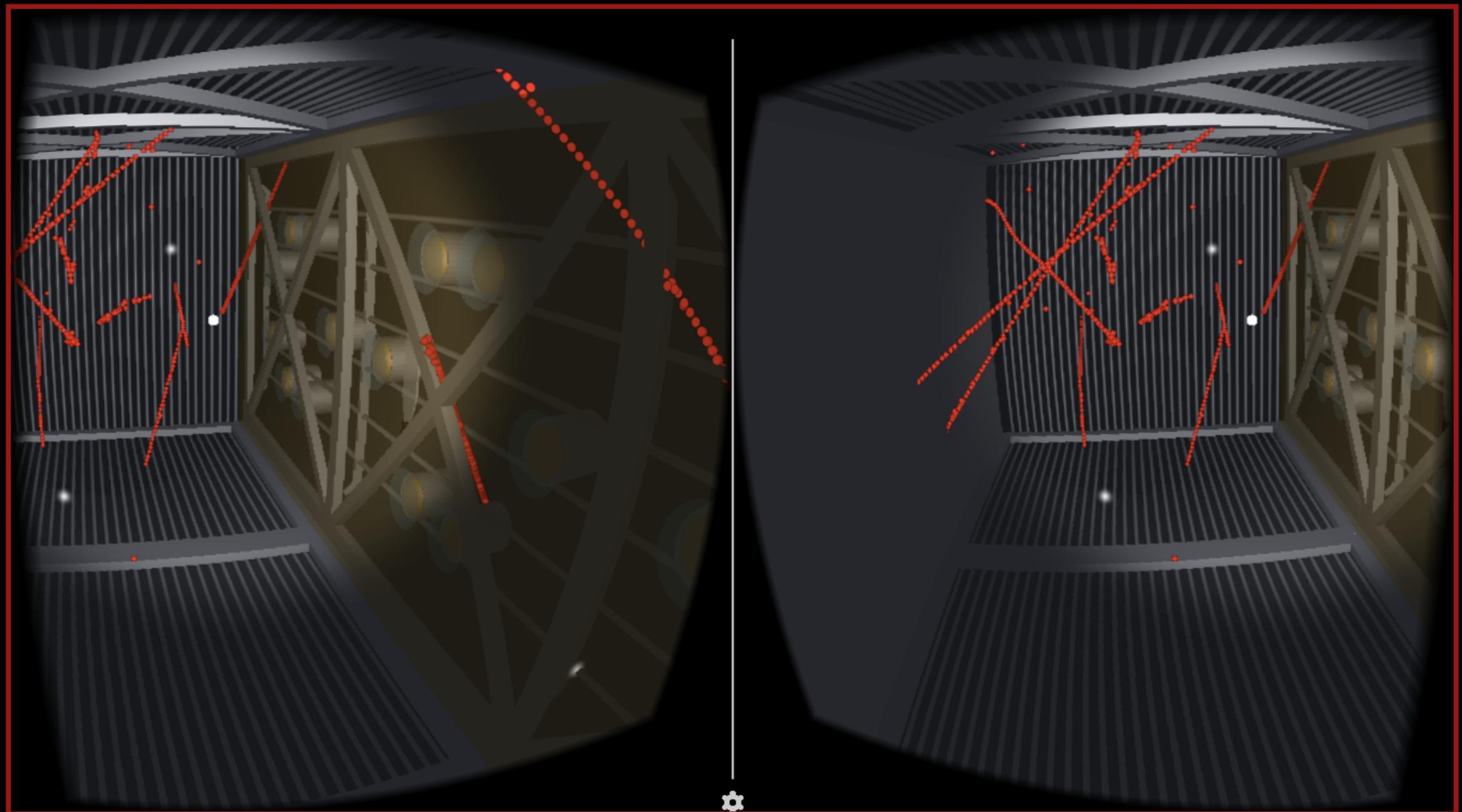
Display Menu



The Display



The VR Mode



The Learning Sections

Learn Menu



What are neutrinos?

Where do neutrinos come from?

How to make a neutrino beam

Neutrino interactions

What is a cross-section?

Cosmic rays

Main Menu

Learn Section



Where do neutrinos come from?

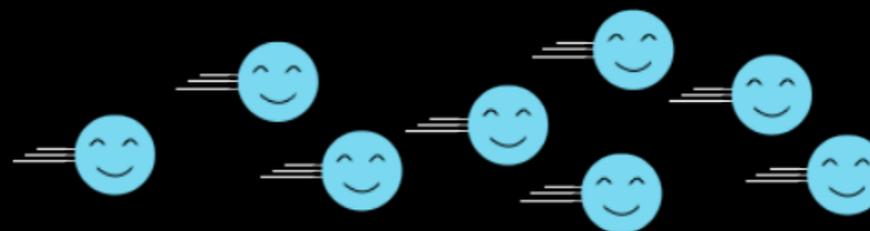
Neutrinos were first produced in the universe some 14 billion years ago, 10 to the -43 seconds after the Big Bang. A mere second later, they were already rapidly moving away from the rest of the hot and dense primary particle soup; scientists are still seeking to detect these neutrinos that survive from the Big Bang. So far, only two sources of extraterrestrial neutrinos have been observed: the sun and supernovae.



Main Menu Learn Menu

1/5

All starts with a neutrino beam produced at Fermilab...

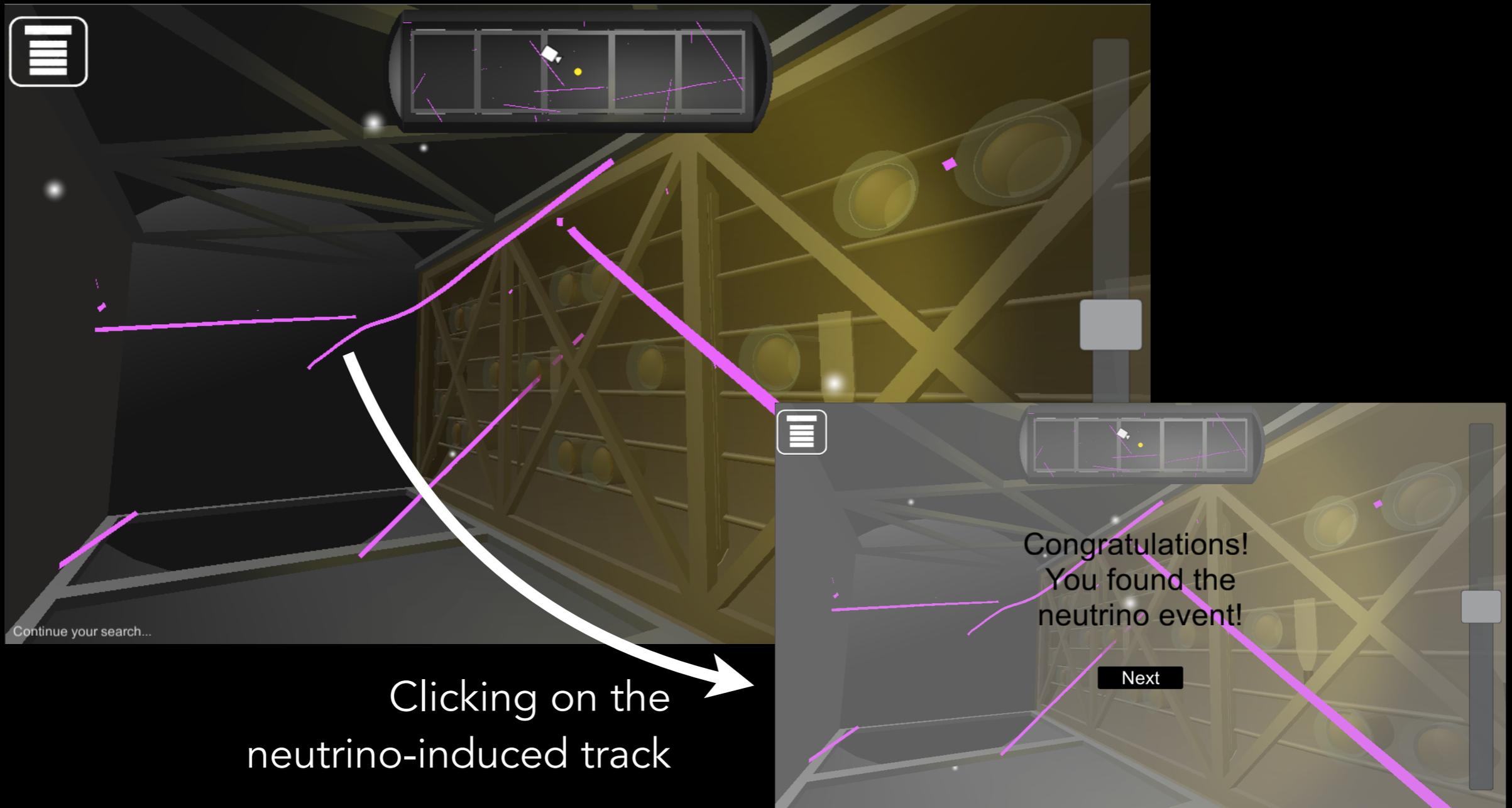


Learn how to make a neutrino beam

Back

Next

The Game



Who was engaged?



Downloads mainly from UK, USA, Canada, Italy, France, Germany, Australia, Switzerland, China, and India.

Who was engaged?



More than 5000 downloads!

- > 1k Android downloads (score 4.9/5)
- > 4k iOS downloads, 273k impressions (score 5/5)

What now?



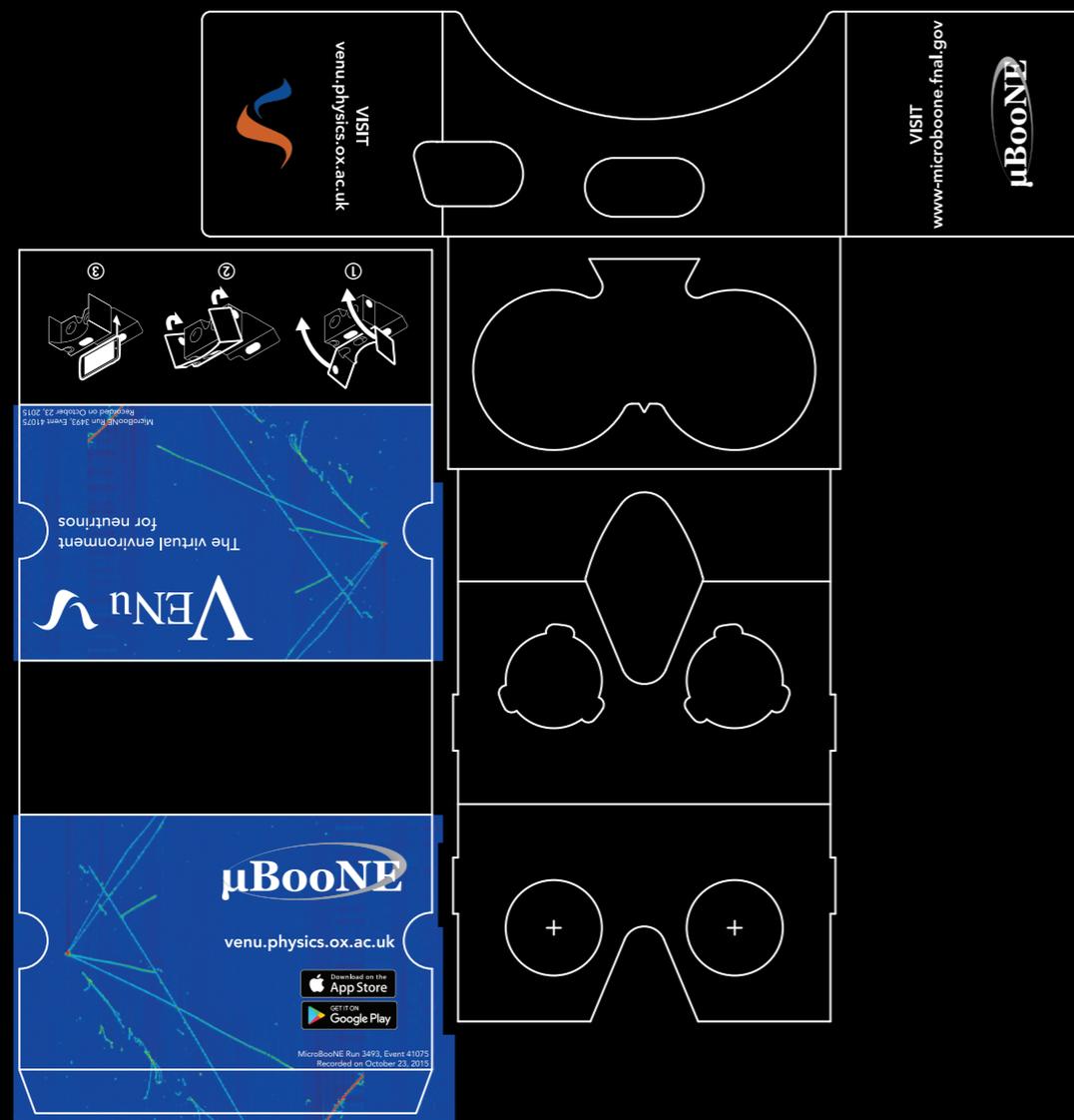
VENu has been used for outreach events at Fermilab and in many other institutions (Oxford, Bern, Columbia, ...)

We are working on upgrading the app and making it available also for other experiments

Custom Cardboards



We designed custom Google Cardboards





Stargazing, Oxford University, 28 January 2017



Stargazing, Oxford University, 28 January 2017



Stargazing, Oxford University, 28 January 2017



EXIT

Chicago Science Festival, 20 May 2017



Oxford Garden Party, Rhodes House, 25 June 2017

Credit: Junior Williamson

Conclusions

Website: venu.physics.ox.ac.uk

The app is currently undergoing maintenance and has been temporarily removed from the stores.
It will be available soon!



MOBILE APP, CARDBOARD VERSION AND GAME

Marco Del Tutto University of Oxford

CORE DEVELOPMENT

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Ariana Hackenburg Yale University

Gene Kim Illinois Math and Science Academy

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LEARN SECTIONS

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GRAPHICS AND DESIGN

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SPECIAL THANKS TO

Sam Zeller Fermilab

Roxanne Guenette University of Oxford